

Artificial intelligence in neuro-oncology: advances and challenges in brain tumor diagnosis, prognosis, and precision treatment

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Abstract

This review delves into the most recent advancements in applying artificial intelligence (AI) within neuro-oncology, specifically emphasizing work on gliomas, a class of brain tumors that represent a significant global health issue. AI has brought transformative innovations to brain tumor management, utilizing imaging, histopathological, and genomic tools for efficient detection, categorization, outcome prediction, and treatment planning. Assessing its influence across all facets of malignant brain tumor management- diagnosis, prognosis, and therapy- AI models outperform human evaluations in terms of accuracy and specificity. Their ability to discern molecular aspects from imaging may reduce reliance on invasive diagnostics and may accelerate the time to molecular diagnoses. The review covers AI techniques, from classical machine learning to deep learning, highlighting current applications and challenges. Promising directions for future research include multimodal data integration, generative AI, large medical language models, precise tumor delineation and characterization, and addressing racial and gender disparities. Adaptive personalized treatment strategies are also emphasized for optimizing clinical outcomes. Ethical, legal, and social implications are discussed, advocating for transparency and fairness in AI integration for neuro-oncology and providing a holistic understanding of its transformative impact on patient care.